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ROCKET MOTOR BLAST EFFECTS AND PROPOSED ABLATIVE PROTECTION FOR--ETC(U)
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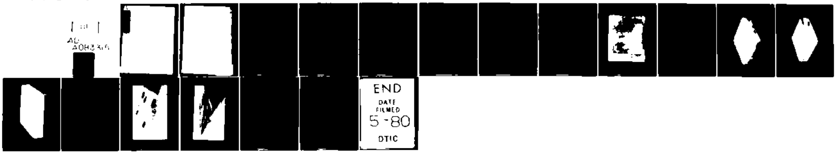

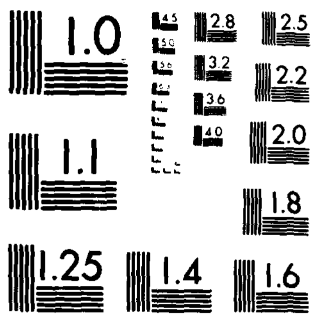

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The results of the flyaway and environmental tests of ablative materials described in this report show that (1) all of the materials tested are satisfactory for use in the RAM launching system and (2) Dow Corning 93-104 w/ graphite is an acceptable adhesive for bonding of the recommended materials to the launcher and/or deck surface.

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FOREWORD

The test descriptions and results reported herein were conducted by the Naval Surface Weapons Center (NSWC) and were supported by the Naval Sea Systems Command (NAVSEA) under SEATASK 404-50015-009-1-S0167 of June 1979.

This addendum was reviewed by C. W. Brandts, Head, Program Branch; and R. J. Arthur, Head, Missile Systems Division.

Released by:

LEMMUEL L. HILL, Head
Weapons Systems Department

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INTRODUCTION

The tests reported in this addendum were conducted as part of the test program described in NSWC TR 79-376*, which, due to the urgency of the data it contained, was published prior to the completion of the following tests:

1. A repeat flyaway test utilizing Dow Corning 93-104 w/graphite

2. Environmental testing of the ablative materials recommended for use in the RAM EX 31 Guided Missile Weapons System

3. Testing to support the recommendation of Dow Corning 93-104 w/graphite as an adhesive in the bonding of ablative material to the launcher and/or deck surface

DOW CORNING 93-104 W/GRAPHITE FLYAWAY TESTING (REPEAT)

Flyaway testing of two materials, FR-1 and Dow Corning 93-104 w/graphite, were conducted and reported in NSWC TR 79-376. It was noted that the impact of at least one piece of rocket motor nozzle had caused accelerated recession in local areas of the Dow Corning 93-104. Because the original test was compromised by the nozzle impacts, the test was repeated. In the repeat test, the material was mounted on an aluminum backplate and located 6 in. (15.24 cm) from the rocket motor nozzle. The same piece of material was used for the four firings at four different angles (0°, 15°, 30°, and 45°). Zero degrees (0°) indicates the material is perpendicular to the rocket motor centerline, and the other angles are measured from the perpendicular. The first firing was at 0°, the second at 15°, etc. The material and backplate, with surrounding protective material, were weighed between each firing. The material was gauged before firing and after all firings were completed.

As a result of these four firings against Dow Corning 93-104, it has been confirmed that the recession in local areas of the original test was accelerated by the impact of the discharged nozzle pieces. The recession experienced on the repeat tests support the recommendation made in the original report that this material would be excellent for solving the reflective energy problem on the back of the guide and the aft canister closure. As the recession rate was fairly low, it probably would be acceptable as a direct impingement ablative material for use where a full rocket motor burn protection is not required. Results of this test are given in Table 1, and a photograph of the material, after firing, is shown in Figure 1.

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* Earl E. Biermann and Allen B. Coates, *Rocket Motor Blast Effects and Proposed Ablative Protection for RAM Launching Sytem EX 43*, NSWC TR 79-376 (Dahlgren, Va., October 1979).

Table 1. Firing Test Data; Flyaway

6 in. (15.2 cm)

Material	Maximum Surface Recession [in. (cm)]	Maximum Recession Rate* [in./sec (cm/sec)]	Weight Before Firing** [lb (kg)]	Weight After Firing** [lb (kg)]	Original Density [lb/in.^{3} (g/cm^3)]	Percent Weight Loss	Thermal Conductivity [Btu/ft/hr/°F (cal/sec/cm/°C)]	Comments
Dow Corning 93-104 w/Graphite	0.121 (0.307)	7.7×10^{-3} (19.6×10^{-3})			0.05 (1.47)		0.202 (0.84×10^{-3})	
0°			87.04 (39.48)	86.13 (39.06)		1.04		Loss of Fondu Fyre surrounding material accounts for excessive weight loss
15°			86.13 (39.06)	85.81 (38.92)		0.40		
30°			85.81 (38.92)	85.72 (38.88)		0.10		
45°			85.72 (38.88)	85.59 (38.82)		0.15		

* Maximum recession rate is based on total of *four firings*.
** Weight shown includes weight of backplate. Same sample of material was subjected to all firings.

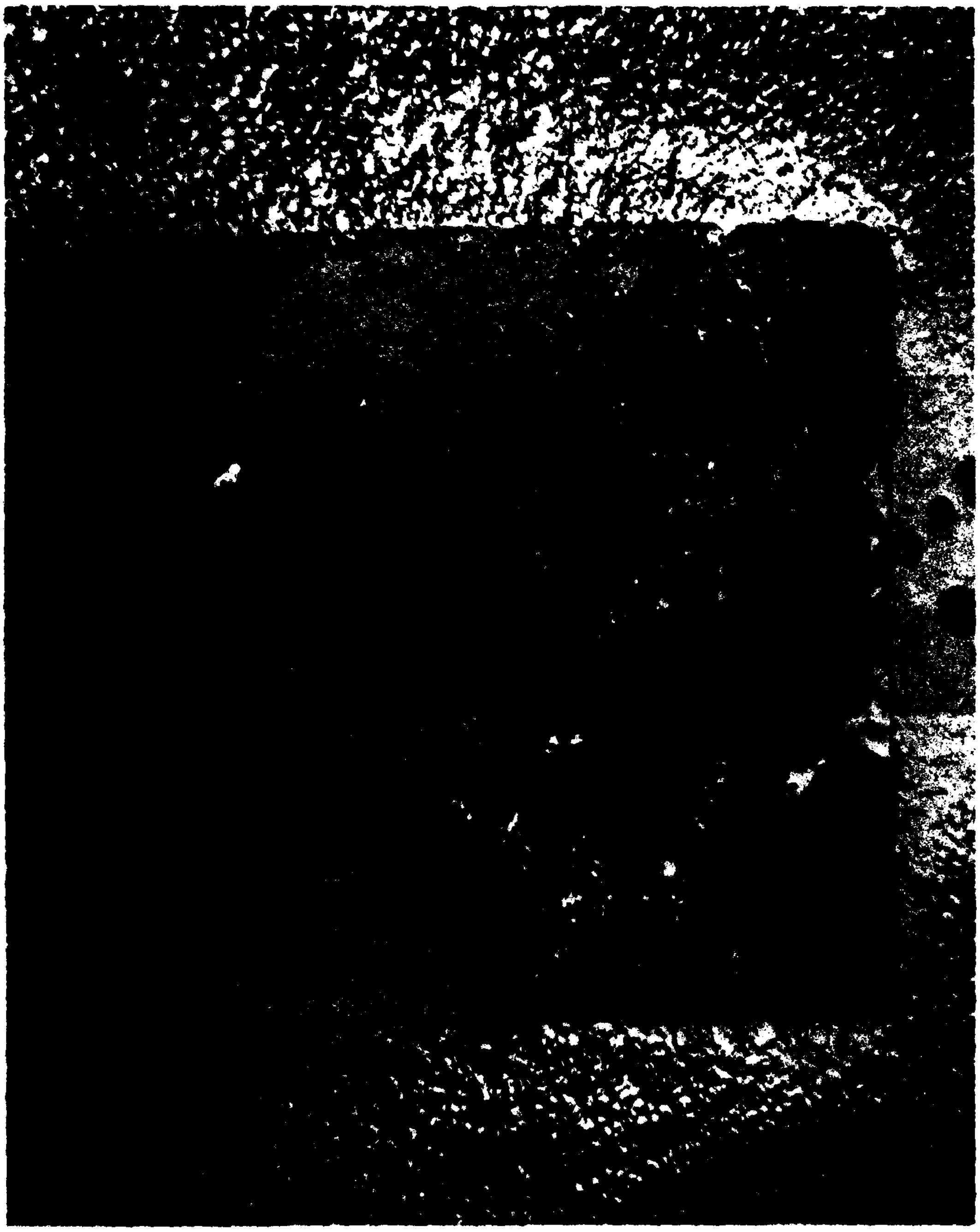

Figure 1. Dow Corning 93-104 After Flyaway Tests

MATERIAL ADHESION TEST

An investigation was conducted to find an acceptable adhesive for bonding the proposed ablative material to the launcher or deck surface. No adhesive was found that alone would bond ablatives to aluminum or steel and that would sustain the temperature, humidity, and shock environment desired. Mechanical fastenings were required to assist the bonding agent in securing the ablative material to the backplate.

Because of the adhesive and heat qualities of Dow Corning 93-104, it was tested as a bonding agent. The first test, which was conducted using Dow Corning 93-104 with and without a primer, showed that a primer was necessary. The ablative material could be separated easily when no primer was used. This was the case for all three ablative materials recommended in NSWC TR 79-376. Photographs of separations due to unprimed surfaces are shown in Figures 2 and 3.

All of the ablative materials and base plates primed with Dow Corning Q36-060 before application of Dow Corning 93-104 showed good bonding. The material could not be pried off without tearing the Dow Corning 93-104 adhesive material. A sample of this material, mounted on aluminum, is shown in Figure 4.

ENVIRONMENTAL TESTING OF ABLATIVE MATERIALS

WATER ABSORPTION TEST

Samples of ablative materials [12 x 12 x 1 in. (30.5 x 30.5 x 2.54 cm)] were bonded to a 0.75-in. (1.9-cm) aluminum backplate and submerged in Potomac River water for 30 days. The adhesive used to bond these materials to the aluminum backplate was HAVEG 9082. Upon removal from the water, the samples were immediately exposed to a full Mk 36 rocket motor blast. The material was located 36 in. from the rocket motor nozzle and at an impingement angle of 0°. The material was examined after the firing and found to have normal recession from the rocket motor blast. The material was gauged and compared with previously tested samples (Table 2). Samples used in the test were HAVEG 41-N, MXB-360, FR-1, and Dow Corning 93-104 w/graphite.

TEMPERATURE SHOCK TEST

The samples of ablative materials that had undergone water absorption and rocket motor blast tests were examined to check the adhesion and then were subjected to a temperature shock test of -31°F to $+118.4^{\circ}$F. After the temperature shock test, it was observed that two of the materials (HAVEG 41-N and FR-1)

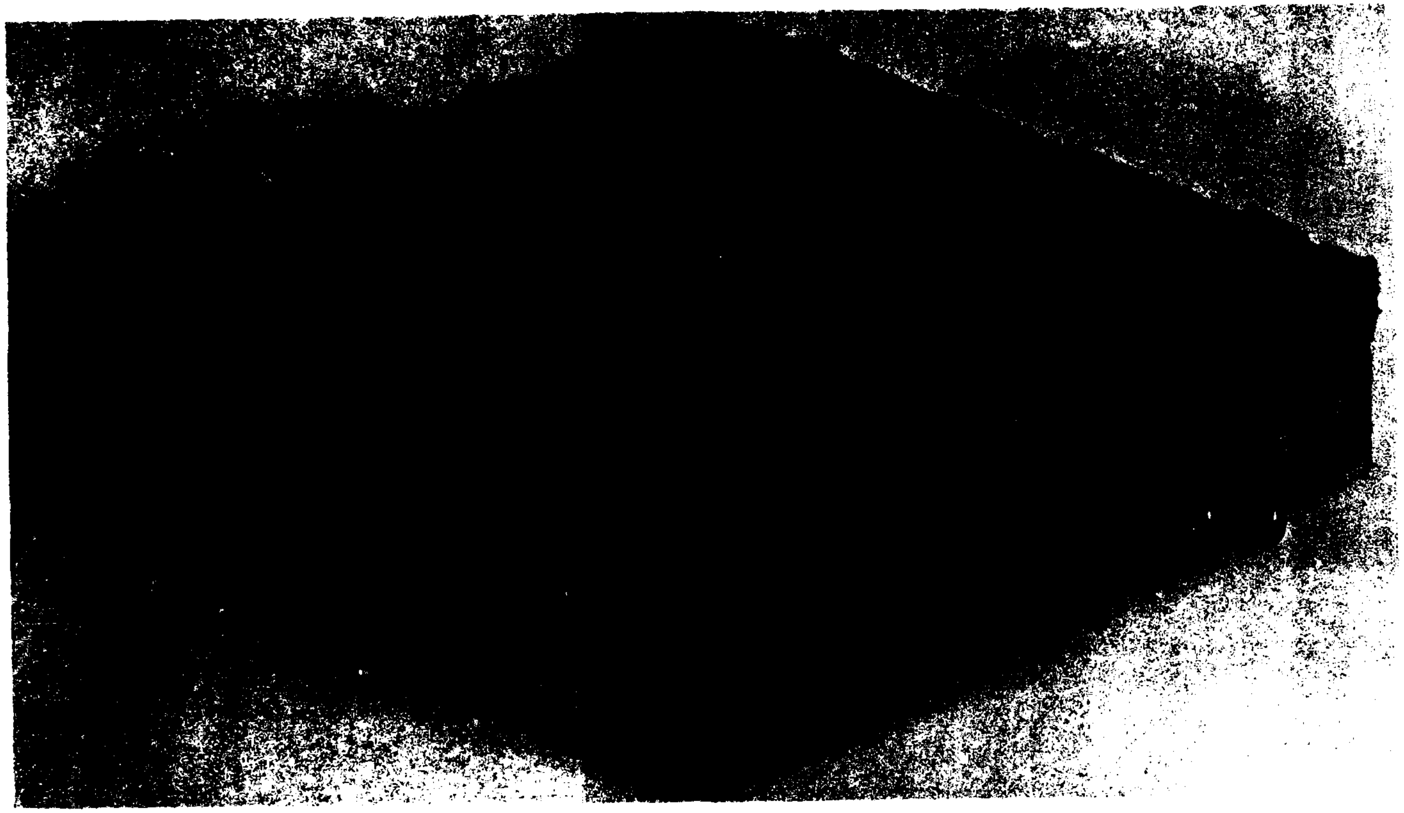

Figure 2. HAVEC 41-N and Dow Corning 93-104 Materials Showing Separation (No Primer)

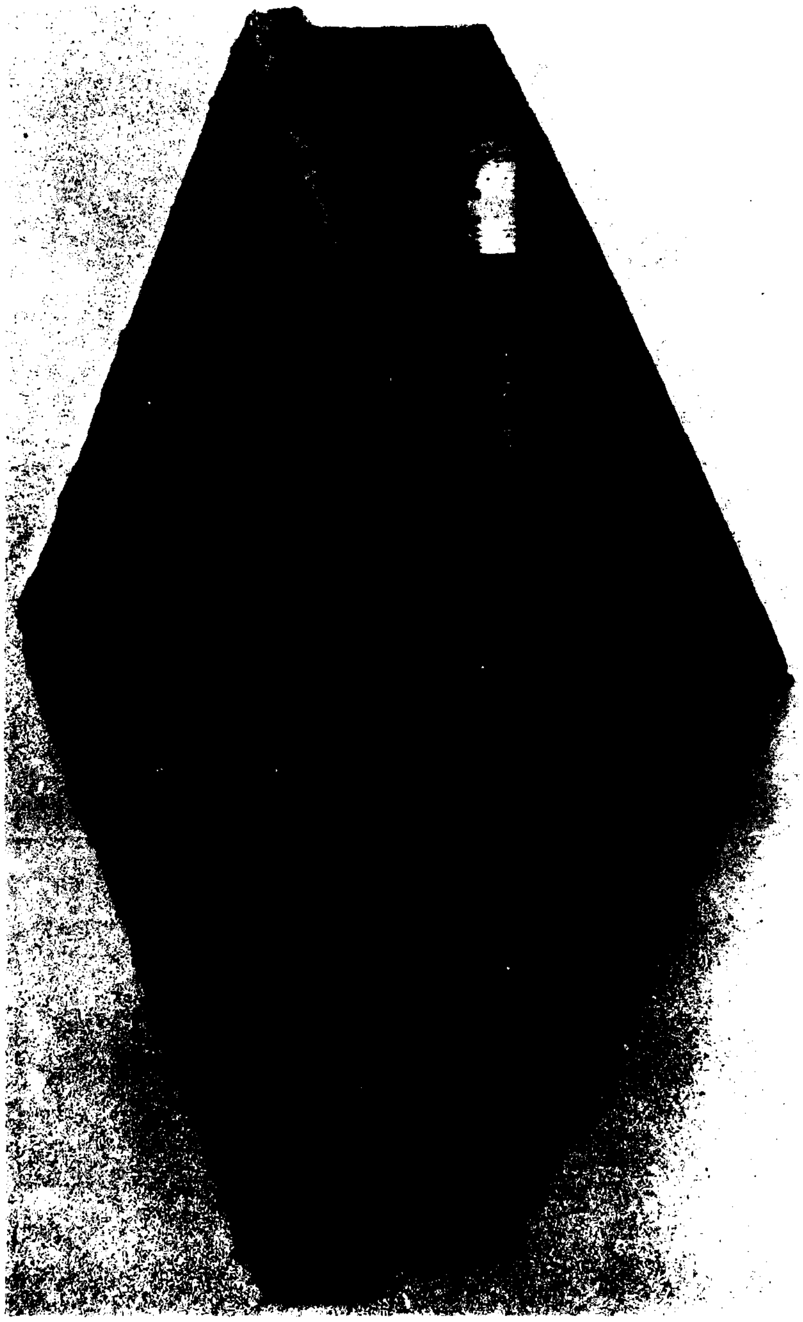

Figure 3. MXB-360 and Dow Corning 93-104 Materials Showing Separation (No Primer)

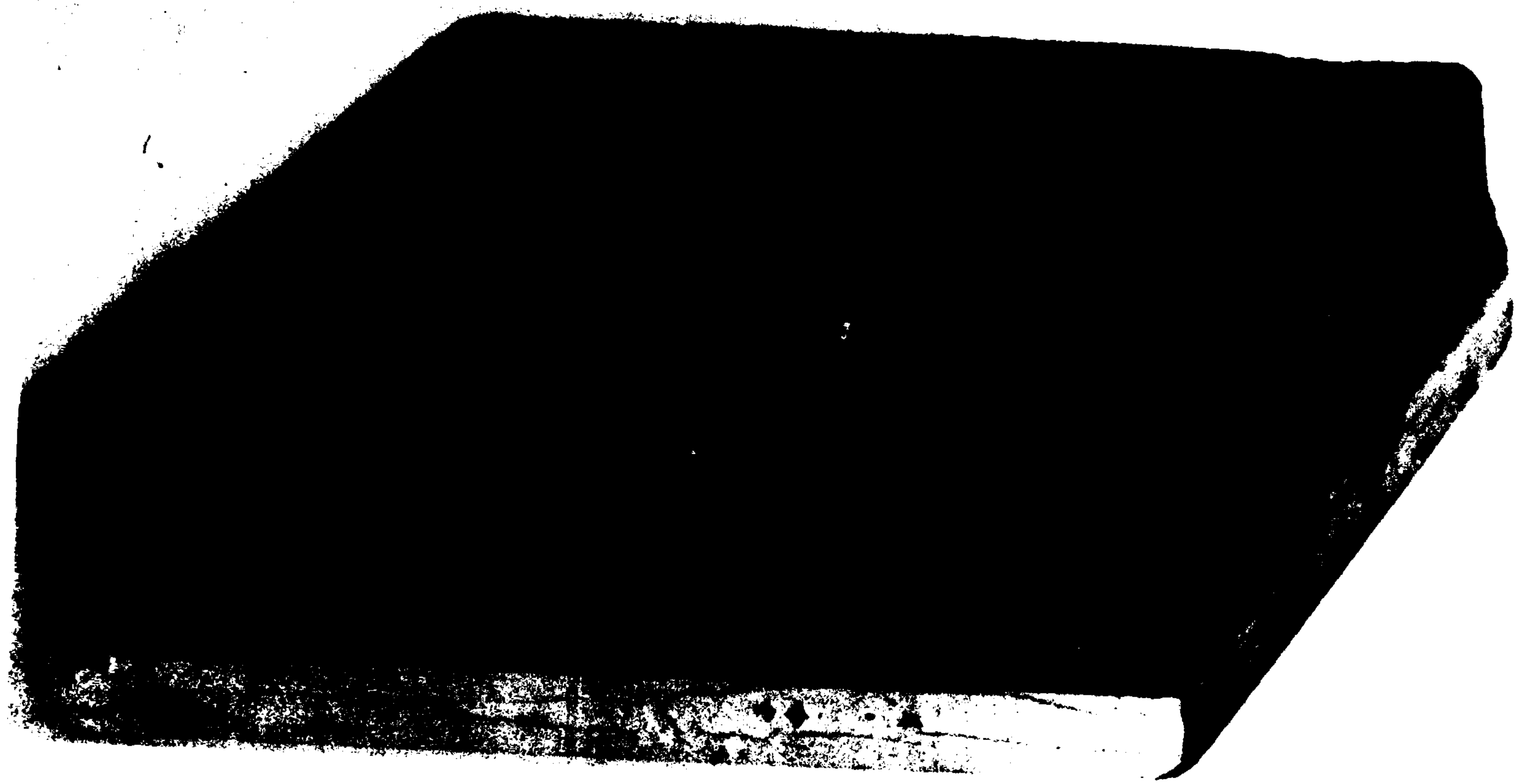

Figure 4. FR-2 Material Bonded to Aluminum Plate With Dow Corning 93-104 as Adhesive (Both Surfaces Primed)

Table 2. Ablative Material Recession Test, Mk 36 Rocket Motor, Full-Period Burn

36 in. (91.4 cm) at 90°

Material	Maximum Recession [in. (cm)] Water-Soaked Sample	Normal Sample
FR-1	0.48 (1.22)	0.43 (1.09)
MXB-36	0.44 (1.12)	0.42 (1.07)
HAVEG 41-N	0.50 (1.27)	0.46 (1.17)
Dow Corning 93-104 w/Graphite	0.39 (0.99)	0.29 (0.74)

were separated from the aluminum backplate. This was probably due to the differences in expansion coefficients between the ablative materials and the aluminum backplate. Results of this test are shown in Figures 5 and 6.

As a result of the separation experienced in the previous test, three smaller samples [6 x 6 in. (15.24 x 15.24 cm)], one of which is shown in Figure 4, were subjected to the temperature shock test. After both surfaces were primed with Dow Corning Q36-060, these samples were bonded to the aluminum backplate with Dow Corning 93-104. All three of these materials were inspected and showed no signs of separation.

VIBRATION TEST

These smaller samples (Figure 4) were then subjected to the vibration test [Type 1 of MIL-STD-167-1 (SHIPS)]. The materials were vibrated in three separate positions: horizontally with the aluminum plate down, horizontally with the aluminum plate up, and vertically. The test samples were inspected after the vibration test and were found to have no visible separations.

IMPACT TEST

One of the same samples that was exposed to the temperature shock and vibration environment was set up for the physical shock test (MIL-STD-901C). This test was conducted at 10-g increments to a maximum of 100 g. The samples were first impacted in the shear direction (10 to 100 g) and then in the flat (90°) position from 10 to 100 g. The sample used in this test was FR-2 bonded to a piece of 0.75-in. (1.9-cm) aluminum with Dow Corning 93-104 w/graphite as the adhesive material. The test sample was inspected after the impact test and no separation was found.

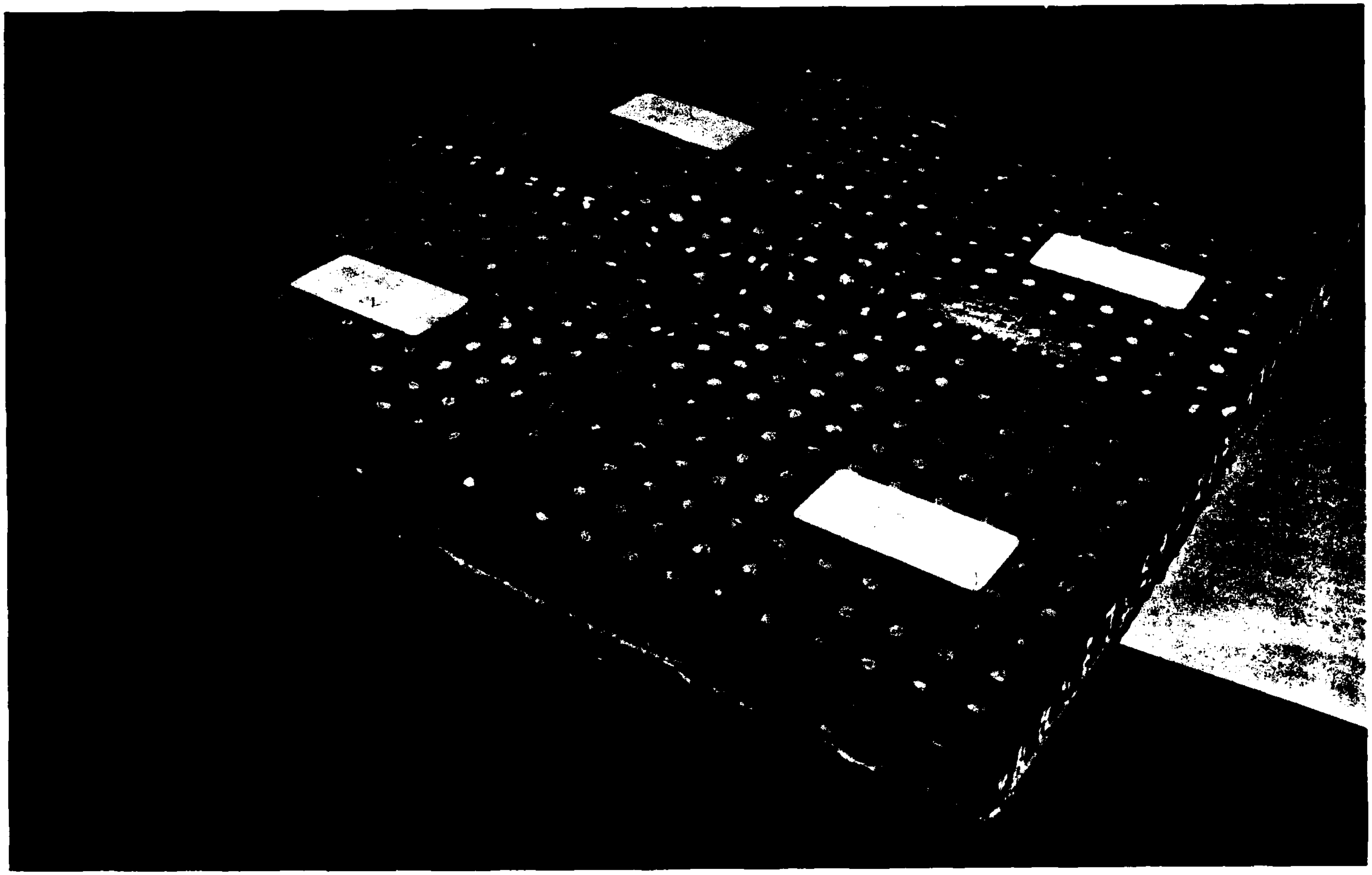

Figure 5. Temperature Shock Test Results, HAVEG 41-N

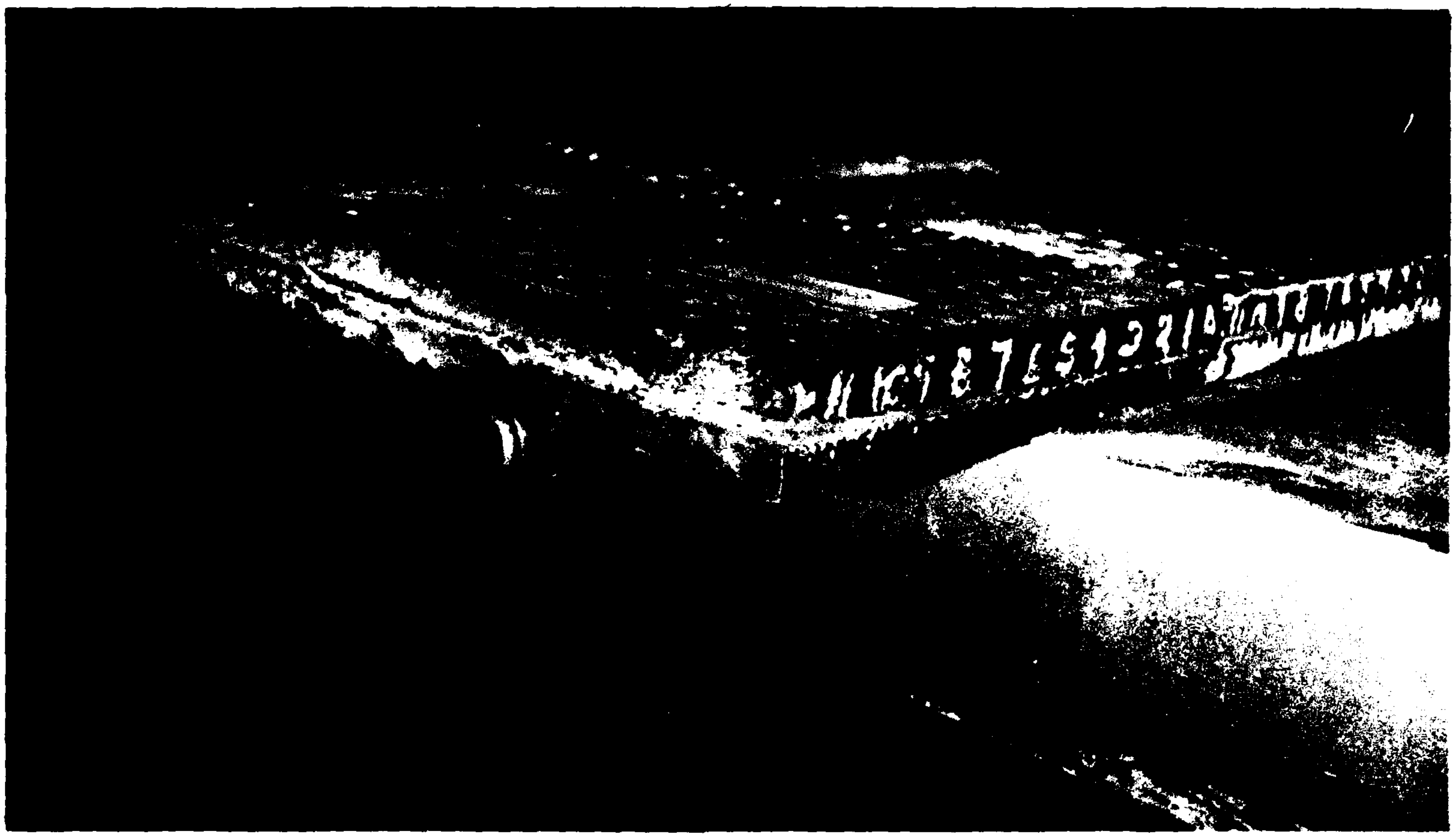

Figure 6. Temperature Shock Test Results, MXB-360

CONCLUSIONS

Based on the results of the environmental and adhesive testing, all of the materials tested were proven satisfactory for use in the RAM launching system. It is further concluded that Dow Corning 93-104 w/graphite is an acceptable adhesive for bonding of the recommended materials to the launcher and/or deck surface.

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